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Municipal and Statewide Land Use Regulations and Housing Prices Across 250 Major US Cities**

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Previous studies of housing price determinants focus either on specific regulations in particular cities/regions, or on cross sections that cover a subset of major cities and regulations. I examine the impact of over 70 indicators of land use regulations on housing prices in 250 major US cities from 1989 to 2006. Cost-increasing municipal regulations (zoning and permit approval delays) and statewide growth/density regulations are shown to be robustly associated with changes in housing prices. In addition, there is also a highly statistically significant effect of statewide executive, legislative, and judicial land use activities on housing prices. Land use regulations are shown to explain a different dimension of the housing price data than demand factors (income, population growth, and population density). However, the estimated increase in housing prices associated with regulations is, on average (over 250 cities), substantial larger than housing demand effects. While the estimated dollar cost associated with regulations may be sizable at times, the results are remarkably consistent with previous studies that were based on smaller cross sections.

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1. Introduction

Much of the empirical housing price literature focuses on the exact determinants of housing supply and demand. As Glaeser (2004) points out, housing demand factors have long been considered essential. In the early 1980s, Poterba (1980) and Summers (1981) documented that inflation increased the interest rate subsidy on mortgages to such an extent that the resulting shift in housing demand explained much of the previous decade's housing price growth. In the 1990s, Mankiw and Weil (1989) highlighted that demographics also drive housing demand. Given the aging of the US population, their results led them to the ominous prediction that, "real housing prices will fall substantially over the next two decades." Contrary to their prediction, housing prices in major US cities rose 54 percent (after accounting for inflation).¹

Housing supply determinants have only recently received intense scrutiny. As late as 2005, systematic housing supply research was still characterized by prominent authors as "at best described as thin" (Green et al., 2005). Seminal was the special journal issue edited by Rosenthal (1999), which contains several surveys that cover distinct dimensions of housing supply. Subsequently, Green et al. (2005), estimate a detailed housing supply function for 45 major cities. This line of research culminates with the finding that the crucial ingredient to understanding housing supply is the stringency of land use regulations. Glaeser (2004) summarizes the evidence and provides broad and compelling support for the hypothesis from studies of US regions and cities. He finds that the negative correlation between housing price growth and new home construction (even after accounting for density) can be explained by regulatory environments (e.g., zoning and permit time costs) in 70 metropolitan areas and their suburbs (Glaeser and Gyourko, 2002).

The data on land use regulations has been a major bottleneck in the study of housing supply. It is unusually time consuming to obtain objective and comparative land use regulation data for informative, representative samples. Objective and comparative data is crucial, and the housing price literature is characterized by an abundance of studies that focus on the effects of specific regulations in particular cities or regions. In surveying the literature, it is tempting to generalize results from the numerous city/region specific studies, and to establish general patterns of how regulations affect housing prices (e.g., Nelson et al. 2001). Although studies of

¹ Based on Census data for median real price of owner-occupied housing described in detail below.

individual jurisdictions are informative, it is unclear whether it is indeed possible to generalize their findings. For example, the economic impact of zoning restrictions that affect lot sizes in California or greenbelts in Colorado are certainly distinct from height restrictions in New York.

From a research design point of view, individual city studies may also be susceptible to selection bias. When researchers select their own housing price indicator(s) the selection may reflect the subset of regulations that are expected, *ex ante*, to be especially relevant to the region. This may lead researchers to neglect other indicators that also hold explanatory power, or inflate their impact as results are generalized *ex post* to other cities in the region or state. The danger is then that the researchers' data selection (and creation) may influence the subsequent results in a systematic manner, validating researchers' prior expectations with unusual frequency.

In contrast, the focus of this paper is to accurately identify variables that are associated with changes in housing prices across 250 major US cities using a land use database that was constructed with a consistent methodology for all cities, and that features over 70 regulatory indicators (Gyourko et al., 2007). The dataset provides a first opportunity to examine the specific regulations that can be tightly associated with changes in housing prices across a large number of US cities. The broad cross section approach eliminates nagging doubts as to whether the impact of a particular regulations in specific city/region studies can be generalized. My empirical strategy, using growth rates rather than price levels as the dependent variable, also mitigates the influence of city-specific fixed effects.

In the public debate, the spectacular run up of US housing prices in the past 20 years has given rise to a number of explanatory hypotheses in the popular literature. Lower mortgage rates, easier access to more creative mortgages, and income/employment growth are only some of the frequently cited explanations. These factors may well contribute to increasing housing prices, but it is noteworthy that they also relate exclusively to housing *demand*. Housing *supply* is not only harder to quantify, but supply hypotheses also reflect opposing view points: environment vs. sprawl, builders vs. planners, parks vs. high-rises, and most divisively: state vs. local growth management.

Growth management is a catch all term for several types of land use regulations at the regional, if not the state, level. In his review of the effects of land use regulations, Brueckner (2007) groups these restrictions into three categories: 1) *urban growth boundaries*, 2) *regulation*

of development densities (e.g., minimum lot-size rules), and 3) *cost-increasing regulations* (facility development and/or regulatory delays in the approval process). The new Wharton database is vitally important because it features an extensive array of land use regulations that cover growth boundaries, density, and cost-increasing regulations at the state and municipal level.

The results from the regression analysis are not only highly statistically significant, but the estimates are also economically significant in that they imply a sizable association between regulations and housing prices. After controlling for demand factors, both state and municipal regulations are shown to affect housing prices. Statewide regulations impact the major cities on three levels: first via growth management plans, second, via specific land use regulations, and third, via the state court's stance on upholding municipal regulations. At the municipal level, the permit and zoning approval delays are associated with changes in housing prices. On average, regulatory measures clearly dominate the demand side effects over the 17 year period under examination. The magnitudes I report are in line with the results of previous, careful studies that were based on smaller cross sections of cities.

Section 2 commences with a brief survey of housing studies to provide the context for the approach taken in this paper. Section 3 reviews the simple theoretical backbone, and Section 4 introduces the empirical implementation. Section 5 discusses the data and Section 6 reports the results. Section 7 reports a battery of tests to examine the robustness of the regression results. Section 8 calculates the dollar costs of regulations and Section 9 discusses their interpretation. Finally, Section 10 highlights policy relevance and summarizes conclusions.

2. Previous Comparative Studies of Housing Prices and Regulations

The method, data, and approach applied in this study must be viewed within the context of the current state of the art of the empirical housing price literature. Therefore, it is important to provide a succinct review of recent housing price studies that include regulations.² In terms of

² Pogodzinski and Sass (1991) provide a structured review of diverse approaches to modeling the effect of housing supply on housing prices. They highlight the multitude of different regulation criteria that have been employed in regional studies, which emphasizes how tenuous the generalizations are that link "regulations" to housing prices, based on individual city studies. Green et al. (2005) provide the most sophisticated empirical implementation of a theory based housing supply model. Although they control for regulations, it is not the objective of their paper to quantify the effects of regulations on housing prices.

broad comparative studies that examine the relationship between land use regulations and housing prices, the seminal papers are Black and Hoben (1985) and Segal and Srinivasan (1985).

Black and Hoben (1985), develop a measure of “restrictive”, “normal”, or “permissive” regulations for 30 US metropolitan areas. They report a correlation of -0.7 between their regulation index and 1980 prices for developable lots. Segal and Srinivasan (1985) survey planning officials in 51 metropolitan areas to find the percentage of undeveloped land taken out of production due to land use regulations. They estimate that regulated cities have 1.7 percent faster annual housing price increases than unregulated cities. Shilling, Sirmans, and Guidry (1991) also employ land use and environmental data from the American Institute of Planners (AIP, 1976) to find that land prices in cities with more stringent land use controls increased 16 percent for every 10 percent increase in regulations. The same authors also examine regulation data from the Urban Land Institute³ to find that average 1990 lot prices in the most restrictive cities were about \$26,000 higher than the average lot price in the least restrictive cities.

Malpezzi (1996) produced one of the most influential comparative studies of the effects of regulations on housing prices using a sample of 56 major US metropolitan areas. He built his analysis on regulatory data collected by the *Wharton Urban Decentralization Project* carried out by Linneman et al. (1990).⁴ His focus was on cost-increasing regulations (zoning/permit delays and approval rates), available land, and adequate infrastructure, aggregated into one index. He also adds a dummy variable to identify when states regulate environmental impact (coastal, wetland or floodplain management) to find that housing permits decline by 42 percent and housing prices increase by 51 percent when one compares lightly and highly regulated cities. Glaeser and Gyourko (2002) examine lot prices in 40 US cities, controlling for the change in the cost of construction. They label the gap between the actual housing prices and the cost of construction (minus the lot price) provocatively the “zoning tax” which is then shown to be associated with cost-increasing regulations (permit and zoning time costs).

³ The data is based on a survey of 11 real estate experts who ranked land use restrictiveness of 30 metropolitan areas on a 10-point scale. Instead of a single regulation criterion, the survey covered 6 broad areas of land use regulations. The Urban Land Institute data covers: 1) wet land management, 2) power plant regulation, 3) critical areas and wilderness, 4) strip mining, 5) flood plains, and 6) tax incentives. The data is binary, indicating only whether regulations exist or not.

⁴ Unfortunately, communication with the authors of the study indicates that this data has been lost.

Other larger scale studies are regional, such as Katz and Rosen's (1987), who analyze 85 cities in the San Francisco Bay area. They find that the selling price of houses increased between 17-38 percent in communities with growth control measures. Levine (1999) expand Katz and Rosen's approach to 490 Californian cities and 18 different land use measures, and reports that land use restrictions "displaced new construction, particularly rental housing, possibly exacerbating the expansion of the metropolitan areas into the interiors of the state." Pollakowski and Wachter (1990) focus on 17 zoning jurisdictions in Montgomery County, Maryland, over a period of 8 years and found that a 10 percent increase in their zoning restriction index increased their housing price index by 27 percent. Interestingly, they also provided the first evidence of spatial externalities associated with regulations: housing prices are shown to rise when the restrictiveness of zoning measures in adjacent jurisdictions increased.

Most recently, Glaeser et al. (2006) assembled a database on zoning codes, subdivision requirements, and environmental regulations in 187 communities in eastern and central Massachusetts to find that regulations reduced the increase in the housing stock from a predicted 27 percent to an actual 9 percent. They predict that, in the absence of regulations, housing prices in Boston's suburbs would have been 23-36 percent lower than observed. In terms of dollar values, they find that the median housing price increased \$155,000 due to regulations from 1990 to 2004. Gyourko and Summers (2006) analyze 218 jurisdictions in the Philadelphia area to show that jurisdictions with average land use regulations saw slightly negative increases in the real cost of single family lots, while municipalities with that most restrictive land use regulations saw lot cost increases of up to 70 percent over 10 years.

My sample features about the same sample size as Gyourko and Sommers (2006), and Glaeser et al. (2006); instead of covering one region, however, my sample is comprised of 250 major US cities. It shares with previous comparative studies of major cities that zoning restrictions and approval delays are considered, but it also extends the focus of previous analyses to include statewide measures, such as growth management plans and even court rulings regarding regulatory enforcement. Malpezzi (1996) also considers statewide measures, but the structure of his data assumes that the effect of such regulations is identical across cities. Instead, the Wharton database provides information on the degree to which each city is impacted by statewide regulations. Finally, instead of focusing on only one or a couple of regulations, I allow all regulations in the Wharton database to potentially affect housing prices.

3. A Simple Model of Housing Prices

The housing model presented below is fundamentally identical to Malpezzi (1996). More complex models of housing prices can certainly be constructed; however, they often produce insurmountable obstacles when one attempts to take them to the data.⁵ The below is therefore a compromise that acknowledges the tradeoff between model complexity and data availability. The standard model of the owner-occupied housing market depends on the demand and supply of owner occupied housing, Q_{ho}^D and Q_{ho}^S , respectively. Demand is a function of the relative price of housing, P_{ho} , income, I_{ho} , and demographic variables, D_{ho} , that relate to density and population size. The demand relationship can be formally represented as

$$Q_{ho}^D = F^D[P_{ho}, I_{ho}, D_{ho}]. \quad (1)$$

The supply of owner occupied housing, Q_{ho}^S , is assumed to depend on the relative price of housing, P_{ho} , land use regulations, R_{ho} , and the prices of all i inputs, P_i^S . The latter reflects, for example, construction and land cost indices.

$$Q_{ho}^S = F^S[P_{ho}, R_{ho}, P_i^S]. \quad (2)$$

Malpezzi (1996) argues that good data for input price indices, especially land, are not available. When prices of inputs are associated with regulations, Malpezzi suggests to rewrite (2) by substituting for P_i^S to represent the supply side equation as the following reduced form

$$Q_{ho}^S = F^S[P_{ho}, R_{ho}]. \quad (2')$$

This specification highlights that regulatory changes affect housing prices both directly and indirectly. The direct effect of regulations reduces the supply of housing to increase the price of housing. An indirect effect of regulations is a change in input prices, which would then affect the supply of housing. The statistical analysis below captures the net impact of both the direct and indirect effects. The reduced form in equation (2') has received additional validity from Green et al. (2005). They estimate extensively detailed, theory based housing supply equations and find that regulations and supply elasticities are highly correlated in that heavily regulated metropolitan areas always exhibited low housing supply elasticities.

⁵ Here I refer the interested reader to Pogodzinski and Sass (1991) for a detailed review.

In equilibrium, supply and demand are equalized, allowing us to solve equations (1) and (2') simultaneously for the housing price. This renders housing prices as a function of land use regulations, income, and demographic variables

$$P_{ho} = F[R_{ho}, I_{ho}, D_{ho}, \varepsilon]. \quad (3)$$

To translate the structural model into a statistical regression model in Section 5, I add a stochastic term, ε , which represents the error introduced to the analysis by, for example, omitted variables or measurement error. The properties of the error term are examined extensively below to explore the validity of the proposed empirical model.

4. Econometric Implementation of the Housing Model

Most authors in the land use literature estimate the reduced form in (3) in levels, where P_{ho} is the price level, which is to be explained as a function of income levels and population levels. At times, changes in demand are also introduced as additional explanatory variables. In terms of the econometrics, the standard cross-section estimator (be it ordinary least squares, or any variant that allows for non-spherical disturbances) is only consistent when individual city effects can be assumed to be uncorrelated with the variable of interest. It is unclear, however, if this assumption is valid in the context of housing prices. Individual city effects, such as the designation as state capital, proximity to Disney World, or to nature, may well drive the *level* of housing prices. One approach to mitigate individual effects is to estimate (3) in terms of growth rates, so that these associated omitted variable biases wash out. While “nature” and “geographical characteristics” of cities may determine its price level, it is a much taller order to link them to changes in prices.

The second issue is that level regressions are generally thought to be susceptible to reporting spurious correlations in the absence of actual causal relationships. Causality is certainly not guaranteed in growth regressions; however, the issue of spurious correlation is mitigated, which renders growth regressions a more stringent empirical test than pure cross-sectional comparisons. Third, in contrast to level regressions, growth regressions can address the frequent confusion in the public debate about the short and long term drivers of housing. The demand for housing – as have seen above – is determined by variables that can change quite quickly over time (income, migration, and density). Housing supply is much more inelastic, especially in the

short run. Examining the *change* in housing prices over long time periods (17 years, in my sample below) allows me to capture the effects of both supply and demand measures with some confidence.⁶

Most importantly, however, I find that growth regressions actually speak most effectively to the question at hand: *what drives the change in housing prices?* Or: *did housing prices increase because of land use restrictions and/or income/population growth?* Level regressions, instead, speak only to the question of whether housing prices are high in cities with high incomes, large populations, and extensive regulations. The estimates below are therefore based on growth regressions where the variable of interest is the *annual compounded growth rate* of housing prices from 1989-2006. This renders the regression to be estimated

$$\hat{P}_{ho} = \alpha + \beta_1 R_{ho} + \beta_2 \hat{I}_{ho} + \beta_3 \hat{Pop}_{ho} + \beta_4 Density + \varepsilon \quad (4)$$

I also include a constant, α , to account for effects that were common to all cities over this period of time. Such common effects might represent changes in the national level of unemployment, changes in mortgage rates, or lending procedures, or liquidity in the mortgage market.⁷

5. Data

5.1 Housing Price Data

Much of the housing price literature wrestles not only with the development of meaningful land use regulation data, but the key variable of interest, housing prices, is also not without issues. There are three alternative approaches to housing prices: *i*) median housing prices for owner occupied homes as reported by the Census, *ii*) sales price data collected by the National Association of Realtors, and *iii*) so called “hedonic” price indices that take into account the characteristics of the housing unit. All three measures are used in the literature, and they feature distinctly different advantages.

It is comforting that the correlation among these three housing prices measures is so high that one should not expect the choice of the type of price data does to drive qualitative results (Malpezzi, 1996). Prices given by *i*) and *ii*) suffer the drawback that they do not control for

⁶ For a complete discussion of growth vs. level regressions I refer the interested reader to Caselli et al. (1996).

⁷ At times the relationship between prices and regulations is seen to be nonlinear (e.g., Malpezzi, 1996). I discuss this possible specification in the robustness section below.

quality increases (such as larger homes, smaller lots, or nicer appliances in houses sold over time). While Census data has the broadest coverage, it reports only median owner occupied housing prices. The National Association of Realtor data features a broader breadth of data, since it is based on multiple listings. However, multiple listing data does not capture the entire market, so *ii*) also does not constitute a representative sample. Hedonic price indices require the correct theoretical specification to capture all housing qualities. If the true model is not known, the estimated valuation is subject to measurement error that then contaminates the coefficient estimates of both housing demand and supply. I follow Malpezzi (1996) and choose Census housing price data.

5.2 Housing Demand Data

I commence with the entire Wharton database sample of 2730 jurisdiction. Census data for all municipalities is available only from the decennial Census. To provide a timely analysis, I use the 2006 Census *5 percent State Level Public-Use Microdata Sample* (PUMS), which covers cities with a minimum of 10,000 inhabitants to maintain the confidentiality of responses, while providing the greatest possible detail to the user. The intersection between the 2730 jurisdictions in the Wharton Database and the 2006 PUMS Microdata renders a data universe of 259 cities for the study below. The Census is also the source of the population data that was used to calculate population and land area (to obtain city density). Finally, the Census also provided data on median household income. At times the regressions below feature less than 259 observations when data on regulations is missing for particular cities. The minimum sample size is 248 cities.

5.3 Regulation Data

As mentioned in the introduction, the current land use literature is fortunate enough to find at its disposal a full dataset of 70 land use indicators for 2730 jurisdictions provided by Gyourko et al. (2007). The 2007 Wharton Regulatory Database speaks to all three major components of land use regulations: urban growth boundaries, regulation of development densities, and cost-increasing regulations. A list of the data collected in the Wharton database is provided in Table 1. Many of these variables are highly correlated, that is why Gyourko et al. (2007) suggest the construction of a “Wharton Index” (formally the *Wharton Residential Land Use Regulation Index*).

The Wharton Index itself is composed of 11 sub-indices that reflect i) *Local Political Pressure*, ii) *State Political Involvement Index*, iii) *State Court Involvement Index*, iv) *Local Zoning Approval Index*, v) *Local Project Approval Index*, vi) *Local Assembly Index*, vii) *Density Restrictions Index*, viii) *Open Space Index*, ix) *Exactions Index*, x) *Supply Restrictions Index*, and xi) *Approval Delay Index*. The exact definitions of these indices are documented in Gyourko et al. (2007). One key sub-index is the *Approval Delay Index*, which will be of consequence below. It is defined as the average time lag (in months) for three types of projects: i) relatively small, single-family project involving fewer than 50 units; ii) a larger single-family development with more than 50 units, and iii) a multifamily project of indeterminate size.

Gyourko et al. (2007) report average regulatory statistics by state and by metropolitan area. While it is common to use major metropolitan areas as the unit of analysis in cross sectional studies, I prefer to use the actual city limits, since some important metropolitan areas are missing data for cities that constitute substantial segments parts of the metropolitan region. In addition, the data was collected at the city level; hence a city-level analysis reflects the relationship between the observed prices and regulations.

While the Wharton Index is informative as a broad measure of regulations, I am also interested in a deeper analysis that identifies exactly which of the 79 subcomponents of the index seem to be related to changes in housing price. One alternative would be to use similar data reduction methods as Gyourko et al. (2007). This approach is limited to providing yet another *type* of “sub-index” for regulations. Instead I am interested in examining *which exact subcomponent* holds explanatory power using a stepwise algorithm I outline below. I hope to present as my final result a set of specific, clearly defined and readily interpretable regulations that are associated with changes in housing prices.

6. Empirical Results

Figure 1 reports the simple correlations between the annual compounded growth in housing prices and a) the Wharton Index, b) income growth, c) population growth, and d) population density. All four are clearly positively correlated with the variable of interest. On the other hand, all four figures also indicate that there is noise in the data that must be picked up by additional regressors in multiple regression analysis. The most tenuous correlation with the